

What is claimed is:

1 1. An organically-functionalized carbon
2 nanocapsule, comprising:
3 a carbon nanocapsule; and
4 at least one kind of organic functional groups
5 bonded thereon,
6 wherein the organically-functionalized carbon
7 nanocapsule is of the following formula:
8 F(-E)n, in which F is the carbon nanocapsule, E
9 is the organic functional group, and n is
10 the number of the organic functional
11 group.

12 2. The organically-functionalized carbon
13 nanocapsule as claimed in claim 1, wherein the carbon
14 nanocapsule is a polyhedral carbon cluster constituting
15 multiple graphite layers having a balls-within-a ball
16 structure, and the diameter of a carbon nanocapsule is 3-
17 100 nm.

1 3. The organically-functionalized carbon
2 nanocapsule as claimed in claim 1, wherein the carbon
3 nanocapsule is hollow.

1 4. The organically-functionalized carbon
2 nanocapsule as claimed in claim 1, wherein the carbon
3 nanocapsule is a metal-filled carbon nanocapsule filled
4 with metals, metal oxides, metal carbides, or alloys.

1 5. The organically-functionalized carbon
2 nanocapsule as claimed in claim 1, wherein n is 1-
3 100,000.

1 6. The organically-functionalized carbon
2 nanocapsule as claimed in claim 1, wherein each E is
3 independently E₁, E₂, E₃, E₄ or E₅, in which each E₁,
4 independently, is Y₁,Y₂ -amino, (Y₁,Y₂ -alkyl)amino, Y₁,Y₂ -
5 ethylenediamino, (dihydroxymethyl)alkylamino, (X₁,X₃ -
6 aryl)amino, or X₁,X₃ -aryloxy; each E₂, independently, is
7 Y₁,Y₂ -alkoxy, (Y₁,Y₂ -amino)alkoxy, (Y₁,Y₂,Y₃ -aryl)oxy,
8 (dihydroxyalkyl)aryloxy, (Y₁,Y₂,Y₃ -alkyl)amino, (Y₁,Y₂,Y₃ -
9 aryl)amino, or dihydroxyalkylamino; each E₃,
10 independently, is Y₁,Y₂,Y₃ -alkoxy,
11 (trihydroxyalkyl)alkoxy, (trihydroxyalkyl)alkylamino,
12 (dicarboxyalkyl)amino, (Y₁,Y₂,Y₃ -alkyl)thio, (X₁,X₂ -
13 aryl)thio, (Y₁,Y₂ -alkyl)thio, (dihydroxyalkyl)thio, Y₁,Y₂
14 -dioxaalkyl; each E₄, independently, is
15 ((glycosidyl)oxoheteroaryl)amino,
16 ((glycosidyl)oxoaryl)amino, (X₁,X₂,X₃ -heteroaryl)amino,
17 (X₁ -diarylketone)amino, (X,X₁ -oxoaryl)amino, (X,X₁ -
18 dioxaaryl) amino, (Y₁ -alkyl, Y₂ -
19 alkyldioxaaryl)amino, (Y₁ -alkyl, Y₂ -
20 alkyldioxaaryl)amino, (di(Y₁,Y₂ -
21 methyl)dioxoheteroaryl)amino, (di(Y₁,Y₂ -
22 methyl)dioxoaryl)amino, ((glycosidyl)heteroaryl)amino,
23 ((glycosidyl)aryl)amino,
24 ((carboxylacetylalkyl)oxoheteroaryl)amino,
25 ((carboxylacetylalkyl)oxoaryl)amino,
26 ((isopropylaminohydroxyalkoxy)aryl)amino, or (X₁,X₂,X₃ -

27 alkylaryl)amino; each E₅, independently, is (X₁, X₂, X₃ -
28 heteroaryl)oxy, (isopropylaminohydroxyalkyl)aryloxy,
29 (X₁, X₂, X₃ -oxoheteroaryl)oxy, (X₁, X₂, X₃ -oxoaryl)oxy, (X₁, Y₁
30 -oxoheteroaryl)oxy, (X₁ -diarylketone)oxy, (X, X₁ -
31 oxoaryl)oxy, (X₁, X₂ -dioxoaryl)oxy, (Y₁, Y₂, di-
32 aminodihydroxy)alkyl, (X₁, X₂ -heteroaryl)thio,
33 ((tricarboxylalkyl)ethylenediamino)alkoxy, (X₁, X₂ -
34 oxoaryl)thio, (X₁, X₂ -dioxoaryl)thio,
35 (glycosidylheteroaryl)thio, (glycosidylaryl)thio, Y₁ -
36 alkyl(thiocarbonyl)thio, Y₁, Y₂ -alkyl(thiocarbonyl)thio,
37 Y₁, Y₂, Y₃ -alkyl(thiocarbonyl)thio, (Y₁, Y₂ -
38 aminothiocarbonyl)thio, (pyranosyl)thio, cysteinyl,
39 tyrosinyl, (phenylalainyl)amino, (dicarboxyalkyl)thio,
40 (aminoaryl)₁₋₂₀ amino, or (pyranosyl)amino;

41 each X, independently, is halide; each of X₁ and X₂,
42 independently, is --H, --Y₁, --O--Y₁, --S--Y₁, --NH--Y₁, --
43 CO--O--Y₁, --O--CO--Y₁, --CO--NH--Y₁, --CO--NY₁Y₂, --NH--
44 CO--Y₁, --SO₂--Y₁, --CHY₁Y₂, or --NY₁Y₂; each X₃,
45 independently, is --Y₁, --O--Y₁, --S--Y₁, --NH--Y₁, --CO--
46 O--Y₁, --O--CO--Y₁, --CO--NH--Y₁, --CO--NY₁Y₂, --NH--CO--
47 Y₁, --SO₂--Y₁, --CHY₁Y₂ or --NY₁Y₂;

48 each of Y₁, Y₂ and Y₃, independently, is --B--Z;

49 each B, independently, is --R_a--O--[Si(CH₃)₂--O--]₁₋
50 ₁₀₀, C₁₋₂₀₀₀ alkyl, C₆₋₄₀ aryl, C₇₋₆₀ alkylaryl, C₇₋₆₀ arylalkyl,
51 (C₁₋₃₀ alkyl ether)₁₋₁₀₀, (C₆₋₄₀ aryl ether)₁₋₁₀₀, (C₇₋₆₀
52 alkylaryl ether)₁₋₁₀₀, (C₇₋₆₀ arylalkyl ether)₁₋₁₀₀, (C₁₋₃₀
53 alkyl thioether)₁₋₁₀₀(C₆₋₄₀ aryl thioether)₁₋₁₀₀, (C₇₋₆₀
54 alkylaryl thioether)₁₋₁₀₀, (C₇₋₆₀ arylalkyl thioether)₁₋₁₀₀,

55 (C₂₋₅₀ alkyl ester)₁₋₁₀₀, (C₇₋₆₀ aryl ester)₁₋₁₀₀, (C₈₋₇₀
56 alkylaryl ester)₁₋₁₀₀, (C₈₋₇₀ arylalkyl ester)₁₋₁₀₀, --R--CO--
57 O--(C₁₋₃₀ alkyl ether)₁₋₁₀₀, --R--CO--O--(C₆₋₄₀ aryl ether)₁₋
58 100, --R--CO--O--(C₇₋₆₀ alkylaryl ether)₁₋₁₀₀, --R--CO--O--
59 (C₇₋₆₀ arylalkyl ether)₁₋₁₀₀, (C₄₋₅₀ alkyl urethane)₁₋₁₀₀ (C₁₄₋₆₀
60 aryl urethane)₁₋₁₀₀, (C₁₀₋₈₀ alkylaryl urethane)₁₋₁₀₀ (C₁₀₋₈₀
61 arylalkyl urethane)₁₋₁₀₀, (C₅₋₅₀ alkyl urea)₁₋₁₀₀, (C₁₄₋₆₀ aryl
62 urea)₁₋₁₀₀ (C₁₀₋₈₀ alkylaryl urea)₁₋₁₀₀, (C₁₀₋₈₀ arylalkyl urea)
63 1-100, (C₂₋₅₀ alkyl amide)₁₋₁₀₀, (C₇₋₆₀ aryl amide)₁₋₁₀₀, (C₈₋₇₀
64 alkylaryl amide)₁₋₁₀₀ (C₈₋₇₀ arylalkyl amide)₁₋₁₀₀, (C₃₋₃₀
65 alkyl anhydride)₁₋₁₀₀, (C₈₋₅₀ aryl anhydride)₁₋₁₀₀, (C₉₋₆₀
66 alkylaryl anhydride)₁₋₁₀₀, (C₉₋₆₀ arylalkyl anhydride)₁₋₁₀₀,
67 (C₂₋₃₀ alkyl carbonate)₁₋₁₀₀, (C₇₋₅₀ aryl carbonate)₁₋₁₀₀, (C₈₋₆₀
68 alkylaryl carbonate)₁₋₁₀₀, (C₈₋₆₀ arylalkyl carbonate)₁₋₁₀₀, -
69 -R₁--O--CO--NH--(R₂ or Ar--R₂--Ar)--NH--CO--O--(C₁₋₃₀ alkyl
70 ether, C₆₋₄₀ aryl ether, C₇₋₆₀ alkylaryl ether, or C₇₋₆₀
71 arylalkyl ether)₁₋₁₀₀, --R₁--O--CO--NH--(R₂ or Ar--R₂--Ar)--
72 -NH--CO--O(C₂₋₅₀ alkyl ester, C₇₋₆₀ aryl ester, C₈₋₇₀
73 alkylaryl ester, or C₈₋₇₀ arylalkyl ester)₁₋₁₀₀, --R₁--C--CO--
74 -NH--(R₂ or Ar--R₂--Ar)--NH--CO--O--(C₁₋₃₀ alkyl ether, C₆₋₄₀
75 aryl ether, C₇₋₆₀ alkylaryl ether, or C₇₋₆₀ arylalkyl
76 ether)₁₋₁₀₀, --CO--NH--(R₂ or Ar--R₂--Ar)--NH--CO--O--, --R₁
77 --O--CO--NH--(R₂ or Ar--R₂--Ar)--NH--CO--O--(C₂₋₅₀ alkyl
78 ester, C₇₋₆₀ aryl ester, C₈₋₇₀ alkylaryl ester, or C₈₋₇₀
79 arylalkyl ester)₁₋₁₀₀, --R₃--O--CO--NH--(R₂ or Ar--R₂--Ar)--
80 NH--CO--O--, --R₁--NH--CO--NH--(R₂ or Ar--R₂--Ar)--NH--CO--
81 -O--(C₁₋₃₀ alkyl ether, C₆₋₄₀ aryl ether, C₇₋₆₀ alkylaryl
82 ether, or C₇₋₆₀ arylalkyl ether)₁₋₁₀₀, --R₁--NH--CO--NH--(R₂
83 or Ar--R₂--Ar)--NH--CO--O--(C₂₋₅₀ alkyl ester, C₇₋₆₀ aryl
84 ester, C₈₋₇₀ alkylaryl ester, or C₈₋₇₀ arylalkyl ester)₁₋₁₀₀,

85 --R₁--NH--CO--NH-- (R₂ or Ar--R₂--Ar) --NH--CO--O-- (C₁₋₃₀
86 alkyl ether, C₆₋₄₀ aryl ether, C₇₋₆₀ alkylaryl ether, or C₇₋₆₀
87 arylkyl ether)₁₋₁₀₀, --CO--NH-- (R₂ or Ar--R₂--Ar) --NH--CO--
88 -O--, --R₁--NH--CO--NH-- (R₂ or Ar--R₂--Ar) --NH--CO--O-- (C₂₋
89 ₅₀ alkyl ester, C₇₋₆₀ aryl ester, C₈₋₇₀ alkylaryl ester, or
90 C₈₋₇₀ arylalkyl ester)₁₋₁₀₀, --R₃--O--CO--NH-- (R₂ or Ar--R₂--
91 Ar)--NH--CO--O--, --R₁--O--CO--NH-- (R₂ or Ar--R₂--Ar) --NH--
92 -CO--NH-- (C₂₋₅₀ alkyl amide, C₇₋₆₀ aryl amide, C₈₋₇₀
93 alkylaryl amide, or C₈₋₇₀ arylalkyl amide)₁₋₁₀₀, or --R₁--NH--
94 -CO--NH-- (R₂ or Ar--R₂--Ar) NH--CO--NH-- (C₂₋₅₀ alkyl amide,
95 C₇₋₆₀ aryl amide, C₈₋₇₀ alkylaryl amide, or C₈₋₇₀ arylalkyl
96 amide)₁₋₁₀₀;

97 each Z, independently, is --C--D--, wherein each C,
98 independently, is --R--, --R--Ar--, --Ar--R--, or --Ar--;
99 and each D, independently, is --OH, --SH, --NH₂, --NHOH, --
100 -SO₃H, --OSO₃H, --COOH, --CONH₂, --CO--NH--NH₂, --CH(NH₂)--
101 COOH, --P(OH)₃, --PO(OH)₂, --O--PO(OH)₂, --O--PO(OH)--O--
102 PO(OH)₂, --O--PO(O⁻)--O--CH₂CH₂NH₃⁺, -glycoside, --OCH₃, --
103 O--CH₂--(CHOH)₄--CH₂--CH, --O--CH₂--(CHOH)₂--CHOH, --C₆
104 H₃(OH)₂, --NH₃⁺, --N⁺HR_bR_c, or N⁺HR_bR_cR_d; wherein each of R,
105 R₁, R₂, R₃, R_a, R_b, R_c, and R_d independently, is C₁₋₃₀ alkyl,
106 each Ar, independently, is aryl.

1 7. The organically-functionalized carbon
2 nanocapsule as claimed in claim 1, wherein the carbon
3 nanocapsule is functionalized by a redox reaction.

1 8. The organically-functionalized carbon
2 nanocapsule as claimed in claim 1, wherein the carbon

3 nanocapsule is functionalized by a cycloaddition
4 reaction.

1 9. The organically-functionalized carbon
2 nanocapsule as claimed in claim 1, wherein the carbon
3 nanocapsule is functionalized by a radical addition
4 reaction.

1 10. An organically-functionalized carbon
2 nanocapsule, comprising:

3 a carbon nanocapsule; and
4 at least one kind of organic functional groups
5 bonded thereon,
6 wherein the organically-functionalized carbon
7 nanocapsule is of the formula:

8 $F(-E)_n$, in which F is the carbon nanocapsule, E
9 is the organic functional group selected
10 from -OH, -C=O, -CHO or -COOH, n is the
11 number of the organic functional group,
12 and the carbon nanocapsule F is
13 functionalized by a redox reaction.

1 11. The organically-functionalized carbon
2 nanocapsule as claimed in claim 10, wherein the carbon
3 nanocapsule is a polyhedral carbon cluster constituting
4 multiple graphite layers having a balls-within-a ball
5 structure, and the diameter of a carbon nanocapsule is 3-
6 100 nm.

1 12. The organically-functionalized carbon
2 nanocapsule as claimed in claim 10, wherein the carbon
3 nanocapsule is hollow.

1 13. The organically-functionalized carbon
2 nanocapsule as claimed in claim 10, wherein the carbon
3 nanocapsule is a metal-filled carbon nanocapsule filled
4 with metals, metal oxides, metal carbides, or alloys.

1 14. The organically-functionalized carbon
2 nanocapsule as claimed in claim 10, wherein n is 1-
3 100,000.

1 15. An organically-functionalized carbon
2 nanocapsule, comprising:

3 a carbon nanocapsule; and
4 at least one kind of organic functional groups
5 bonded thereon,
6 wherein the organically-functionalized carbon
7 nanocapsule is of the following formula:
8 F(-E)n, in which F is the carbon nanocapsule, E
9 is the organic functional group selected
10 from -NHAr, -N+(CH₃)₂Ar, =CCl₂ or amino
11 group, n is the number of the organic
12 functional group, and the carbon
13 nanocapsule F is functionalized by a
14 cycloaddition reaction.

1 16. The organically-functionalized carbon
2 nanocapsule as claimed in claim 15, wherein the carbon
3 nanocapsule is a polyhedral carbon cluster constituting
4 multiple graphite layers having a balls-within-a ball
5 structure, and the diameter of a carbon nanocapsule is 3-
6 100 nm.

1 17. The organically-functionalized carbon
2 nanocapsule as claimed in claim 15, wherein the carbon
3 nanocapsule is hollow.

1 18. The organically-functionalized carbon
2 nanocapsule as claimed in claim 15, wherein the carbon
3 nanocapsule is a metal-filled carbon nanocapsule filled
4 with metals, metal oxides, metal carbides, or alloys.

1 19. The organically-functionalized carbon
2 nanocapsule as claimed in claim 15, wherein n is 1-
3 100,000.

1 20. An organically-functionalized carbon
2 nanocapsule, comprising:

3 a carbon nanocapsule; and
4 at least one kind of organic functional groups
5 bonded thereon,

6 wherein the organically-functionalized carbon
7 nanocapsule is of the following formula:

8 F(-E)n, in which F is the carbon nanocapsule, E
9 is the organic functional group selected
10 from -OH, -OSO₃⁻, -C(CH₃)₂COOCH₃ or -
11 C(CH₃)₂CN, n is the number of the organic
12 functional group, and the carbon
13 nanocapsule F is functionalized by a
14 radical addition reaction.

1 21. The organically-functionalized carbon
2 nanocapsule as claimed in claim 20, wherein the carbon
3 nanocapsule is a polyhedral carbon cluster constituting

4 multiple graphite layers having a balls-within-a ball
5 structure, and the diameter of a carbon nanocapsule is 3-
6 100 nm.

1 22. The organically-functionalized carbon
2 nanocapsule as claimed in claim 20, wherein the carbon
3 nanocapsule is hollow.

1 23. The organically-functionalized carbon
2 nanocapsule as claimed in claim 20, wherein the carbon
3 nanocapsule is a metal-filled carbon nanocapsule filled
4 with metals, metal oxides, metal carbides, or alloys.

1 24. The organically-functionalized carbon
2 nanocapsule as claimed in claim 20, wherein n is 1-
3 100,000.